

## Jury Member Report – Doctor of Philosophy thesis

Name of Candidate: Vsevolod Iakovlev

PhD Program: Physics

Title of Thesis: Advanced Synthesis of Single-Walled Carbon Nanotubes Films by Aerosol Method for Electro-Optical Application


Supervisors: Prof. Albert Nasibulin, Skoltech, Russia  
Prof. Esko Kauppinen, Aalto, Finland

Chair of PhD defense Jury: Prof. Keith Stevenson, Skoltech

Email: [K.Stevenson@skoltech.ru](mailto:K.Stevenson@skoltech.ru)

Date of Thesis Defense: October 4, 2019

Name of the Reviewer:

<p>I confirm the absence of any conflict of interest</p> <p>(Alternatively, Reviewer can formulate a possible conflict)</p>	<p><b>Signature:</b></p>  <p><b>Date: 20-08-2019</b></p>
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*The purpose of this report is to obtain an independent review from the members of PhD defense Jury before the thesis defense. The members of PhD defense Jury are asked to submit signed copy of the report at the latest on August 13<sup>th</sup>. The Reviewers are asked to bring a copy of the completed report to the thesis defense and to discuss the contents of each report with each other before the thesis defense.*

*If the reviewers have any queries about the thesis which they wish to raise in advance, please contact the Chair of the Jury.*

### Reviewer's Report

Reviewers report should contain the following items:

- Brief evaluation of the thesis quality and overall structure of the dissertation.
- The relevance of the topic of dissertation work to its actual content
- The relevance of the methods used in the dissertation
- The scientific significance of the results obtained and their compliance with the international level and current state of the art
- The relevance of the obtained results to applications (if applicable)

- The quality of publications

Please write your statement / summary of issues to be addressed before the thesis defense here.

I am writing this letter to provide an evaluation of MSc Vsevolod Lakovlev on his original creative work (i.e. thesis) entitled "Advanced Synthesis of Single-walled Carbon Nanotube Films by Aerosol CVD Method for Electro-optical Applications," in the completion of PhD requirements at Skoltech University.

Overall, his thesis contains original and forefront work on the synthesis, characterization and application of SWCNT films for next generation electro-optics. His thesis is arranged into two main components: Methods and Application. The scientific outcomes are reflected in seven manuscripts; Most published in high impact factor journals with Vsevolod's contributions to the work clearly outlined in the beginning of the thesis. What is represented in the thesis is a significant body of work given complexity of the SWNT reactor development and synthesis system and given the intensive amount of characterization experiments that need to be performed to understand their structural, compositional and electro-optical properties. In particular, three electro-optical devices with were developed i) a bolometer based on a freestanding SWCNT film showing response time of 2.6 ms at room temperature and 1 mbar (several times faster than the corresponding industrially applied devices); ii) a SWCNT-based heating element of fiber Bragg grid for smooth tuning of the resonant wavelength and a stable laser signal; iii) a saturable absorber based on SWCNT films showing femtosecond pulse generation and low degradation rate. The work is very forefront and of high scientific value and impact.

First with regard to the methods part of the thesis. The background literature, methods, experimental set-ups, and basic description of measurements and their interpretation of standard results in the dissertation is well described and documented. The literature (references) overviewed is fast moving and several new works are being published on a daily basis so what is presented is thorough but not quite up-to-date. My main criticism in the methods and characterization section is that the quality of several figures should be improved as they are of low resolution and will not reproduce well. Many of the axes and labels are hard to read as they are too small or even at times cut-off especially in Chapter 4 (possible from PDF conversion).

The most significant part of the thesis are Chapter 5 and 6 with the development of artificial neural network approaches to optimize the synthesis of SNWTs and the laser based treatment of SWNT films. These two chapters are well done with regard to describing the science. His contributions here significantly enable the applications in three areas. While the proof of concept studies for applications is somewhat in the infancy stages it is understandable why these sections contain little data. I interpret it as that the thesis is only including work done by Vsevolod and not the entire team of collaborations.

Overall this thesis work, highlights the essential importance of coupling both fundamental science with pragmatic materials science and engineering to establish new proof of concepts in

this area. Vselvod has done outstanding original work and addresses many challenges of characterization and analysis to support the outcomes indicated in this thesis.

Considering his performance in original research achievements, I wholeheartedly recommend the acceptance of his PhD thesis with possible consideration of slight modifications especially with regard to formatting of his thesis.

**Provisional Recommendation**

*I recommend that the candidate should defend the thesis by means of a formal thesis defense*

*I recommend that the candidate should defend the thesis by means of a formal thesis defense only after appropriate changes would be introduced in candidate's thesis according to the recommendations of the present report*

*The thesis is not acceptable and I recommend that the candidate be exempt from the formal thesis defense*